

REMARKS

Attorney for Applicants has carefully reviewed the outstanding Office Action on the above-identified application. Applicants have amended the application, as set forth herein, and respectfully submit that the application, as amended, is in condition for allowance.

Applicants have amended claims 1, 2, 11, 12, 21, 22, 32, and 33 and cancelled claims 23 and 34 to overcome the rejections cited in the Office Action. Applicants submit that the claimed invention, as amended, is patentable over the cited references.

Applicants' claimed invention relates to a method and apparatus for remote measurement of vibration and properties of objects. An electromagnetic signal, such as a laser beam, light beam, or RF signal, is amplitude modulated by the invention. This creates an amplitude modulated signal or, in other words, a signal with an envelope defined by the modulating waveform. The amplitude modulated signal is transmitted to a vibrating object by a transmitter. Vibrations of the object phase modulate the amplitude modulated signal. In other words, the envelope of the amplitude modulated signal is phase modulated by vibrations of the object. The reflected signal is received by a receiver which extracts the envelope and sends the phase-modulated envelope to a demodulator. The demodulator demodulates the phase-modulated envelope of the amplitude modulated signal to provide information about properties of the object, including vibration.

Claims 1, 2, 7, 9-12, 17, 19-23, 27, 29-34, 38, and 41-43 were rejected as being anticipated by U.S. Patent No. 4,554,836 to Rudd. Applicants submit that the pending claims, as amended herein, are patentable over this reference.

Rudd discloses a laser vibrometer. A laser light source generates a laser beam that is modulated by an acoust-optic modulator, shifting the *frequency* of a portion of the laser beam. The modulated light beam passes to a vibrating object, which scatters the light. The reflected light is heterodyned with the unshifted portion of the laser beam in a photodiode to produce a phase modulated signal at the acoustic frequency of the modulator. Surface displacement is measured as a function of instantaneous phase shift, and surface velocity as a function of the rate of change of the phase shift.

Rudd fails to teach each element of Applicants' claimed invention as set forth in amended claim 1. Specifically, Rudd fails to teach or suggest an electromagnetic wave vibrometer apparatus comprising: a signal generator for generating an electromagnetic signal; **a modulator for amplitude modulating the electromagnetic signal to produce an amplitude modulated signal**; a transmitter for transmitting the **amplitude modulated signal** at a vibrating object; a receiver for receiving a reflected **phase-amplitude modulated signal** from the vibrating object and extracting the envelope of the reflecting signal; a demodulator for demodulating the **phase modulated envelope of the amplitude modulated signal**; and a signal processor for analyzing a vibration waveform of the demodulated signal, as set forth in amended claim 1. While Rudd teaches *frequency* modulating a laser signal prior to transmission of the signal to the vibrating object, Rudd fails to teach *amplitude* modulating the signal prior to transmission of the signal.

Further, in the present invention, the envelope of the amplitude modulated signal is phase modulated by the vibrating object. This phase-modulated envelope of the amplitude modulated signal is extracted and analyzed to provide information about properties of the object, including vibration. As such, Applicants respectfully submit that amended claim 1 and claims 2-10, which depend from claim 1 and contain all of the limitations thereof, are patentable over Rudd.

Rudd further fails to teach each element of Applicants' claimed invention as set forth in amended claim 11. Rudd fails to teach or suggest an apparatus for remotely measuring properties of an object comprising: a signal generator for generating an electromagnetic signal; a **modulator for amplitude modulating the electromagnetic signal to produce an amplitude modulated signal**; a transmitter for transmitting the **amplitude modulated signal** at an object; means for vibrating the object to phase modulate the **amplitude modulated signal** transmitted at the object; a receiver for receiving a reflected **phase and amplitude modulated signal** from the object; a demodulator for demodulating the **phase and amplitude modulated signal**; and a signal processor for analyzing the vibration waveform of the demodulated signal, as set forth in amended claim 11. Rudd is devoid of any teaching to amplitude modulate a signal prior to transmitting the signal to a vibrating object, and the reflected signal in Rudd is not phase and amplitude modulated. Accordingly, Applicants submit that claim 11, as amended, and claims 12-20, which depend from claim 11 and contain all of the limitations thereof, are patentable over Rudd.

Rudd fails to teach each element of Applicants' claimed invention as set forth in amended claim 21. Rudd fails to teach or suggest a method of remotely measuring vibration comprising:

generating an electromagnetic signal; **modulating the electromagnetic signal to produce an amplitude modulated signal**; transmitting the **amplitude modulated signal** at a vibrating object; receiving a reflected **phase-amplitude modulated signal** from the vibrating object and extracting the envelope; demodulating the **phase-modulated envelope**; and analyzing the demodulated signal, as set forth in amended claim 21. As such, Applicants submit that amended claim 22 and 24-31, which depend from claim 21 and contain all of the limitations thereof, are patentable over Rudd.

Rudd fails to teach or suggest each element of Applicants' claimed invention as set forth in amended claim 32. Rudd fails to teach or suggest providing a method for remotely determining properties of an object comprising: **modulating an electromagnetic signal to produce an amplitude modulated signal**; transmitting the **amplitude modulated signal** at an object; vibrating the object; receiving reflected **phase-amplitude modulated signals** from the vibrating object and extracting the envelope; and processing the **phase modulated envelope** to extract information about the properties of the object, as set forth in amended claim 32. Accordingly, amended claim 32, and claims 33 and 35-43, which depend from claim 32, are patentable over Rudd.

Claims 3-6, 13-16, 24-26, and 35-37 were rejected as being obvious over Rudd in view of U.S. Patent No. 4,481,825 to Kljuev, et al. In view of Applicants' amendments to independent claims 1, 11, 21, and 32, and for the reasons set forth below, Applicants respectfully submit that its pending claims are patentable over Rudd in view of Kljuev, et al.

Kljuev, et al. discloses a device for measuring vibrations including a microwave generator and an antenna for transmitting microwaves to an object to be investigated. Microwaves are phase modulated by the object and are reflected back to a detector, where they are mixed (heterodyned) with the unmodulated microwaves to produce a signal indicative of the object's vibration.

Neither Rudd nor Kljuev, et al., taken alone or in combination, teach or suggest each element of Applicants' claimed invention, as set forth in claims 3-6, 13-16, 24-26, and 35-37, which depend, respectively, from amended claims 1, 11, 21, and 32. Each of these claims recites the limitation of **amplitude modulating** an electromagnetic signal prior to transmitting the signal to a source, and receiving and processing **phase-amplitude modulated signals** reflected from the source to determine the object's vibrations and characteristics. Rudd, discussed earlier, *frequency* modulates a probe signal prior to transmission of the signal, and fails to teach or suggest amplitude modulating a signal. Likewise, Kljuev, et al. is absent and teaching, suggestion, or motivation for amplitude modulating a signal prior to transmission of the signal. As such, Applicants submit that claims 3-6, 13-16, 24-26, and 35-37, which depend, respectively, from amended independent claims 1, 11, 21, and 32 and contain all of the limitations thereof, are patentable over Rudd in view of Kljuev, et al.

Applicants further submit that claims 8, 18, 28, and 39, which were rejected as being obvious over Rudd in view of U.S. Patent No. 5,897,494 to Flock, et al., are patentable over these references.

Flock, et al. discloses a vibrometer which detects the variation of the speckle interference pattern of reflected waves as a means for determining the amplitude and frequencies of vibrations of structures. A wave source irradiates an object to be investigated, and the diffuse reflectance of the textural surfaces of the object reflects the incident wave radiation of the object as a speckle interference pattern. A photodetector receives the reflected incident waves, and the speckle interference pattern is analyzed to determine the object's variation.

Neither Rudd nor Flock, et al., taken alone or in combination, teach or suggest each element of Applicants' claimed invention, as set forth in claims 8, 18, 28, and 39, which depend, respectively, from amended claims 1, 11, 21, and 32. Each of these claims recites the limitation of **amplitude modulating** an electromagnetic signal prior to transmitting the signal to a source, and receiving and processing **phase-amplitude modulated signals** reflected from the source to determine the object's vibrations and characteristics. Rudd discloses *frequency* modulating a signal prior to transmission of the signal, and fails to teach or suggest amplitude modulating a signal. Flock, et al. is also devoid of any teaching, suggestion, or motivation to amplitude modulate a signal prior to transmission of the signal. Accordingly, Applicants submit that claims 8, 18, 28, and 39, which depend, respectively, from amended independent claims 1, 11, 21, and 32 and contain all of the limitations thereof, are patentable over Rudd in view of Flock, et al.

Finally, Applicants submit that claim 40, which was rejected as being obvious over Rudd in view of U.S. Patent No. 5,495,767 to Wang, et al., is patentable over these references.

Wang, et al. discloses a laser vibrometer which includes a laser beam, a beam splitter, two reflectors, an optical processor having two optical sensors, a digitizer for converting an analog signal to a digital signal, a flip-flop circuit, and a counter.

Neither Rudd nor Wang, et al., taken alone or in combination, teach or suggest each element of Applicants' claimed invention as set forth in claim 40, which depends from amended claim 32. Claim 40 recites the limitation of **amplitude modulating** an electromagnetic signal prior to transmitting the signal to a source, and receiving an processing **phase-amplitude modulated signals** reflected from the source to determine the object's vibrations and characteristics. Rudd discloses *frequency* modulating a signal prior to transmission of the signal, and fails to teach or suggest amplitude modulating a signal. Similarly, Wang, et al. is also devoid of any teaching, suggestion, or motivation to amplitude modulate a signal prior to transmission of the signal. Accordingly, Applicants submit that claim 40, which depends from amended independent claims 32 and contains all of the limitations thereof, is patentable over Rudd in view of Wang, et al.

Applicants have added new dependent claims 44-47 to further define the claimed invention. Claims 44-47 provide that the amplitude modulated signal is modulated in the GHz range. No new matter is believed to have been added by this amendment.

All issues raised in the Office Action are believed to be addressed. Claims 1, 2, 11, 12, 21, 22, 32, and 33 were amended, claims 23 and 34 were cancelled, and claims 44-47 were added. Claims 1-22, 24-33, and 35-47 are pending in this application, and are believed to be in condition for allowance. No new matter is believed to have been added. Re-examination is requested and favorable action solicited.

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Respectfully submitted,



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